The Opioid Overdose Crisis in New York: A Study on the Impacts of Policy, Demographics, and Treatment Access

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Abstract

There is a notable gap in research examining the opioid epidemic between 2016 and 2021, particularly across all counties in New York state. This study aims to fill this gap by analyzing the factors contributing to opioid overdose deaths, focusing on demographics, drug-related crime, healthcare events, and policy. The model reveals that opioid overdose death rates are higher across counties with larger populations of Hispanic or Latino, Asian, and multiracial populations, highlighting potential disparities in substance abuse treatment access. Additionally, the findings show that healthcare visits for opioid overdose or abuse are associated with increasing mortality rates, suggesting a lack of coordinated care across counties. However, the interaction between healthcare facility visits for opioid abuse and admissions to OASAS-certified drug treatment programs is associated with a decrease in opioid overdose deaths. This is likely due to the effectiveness of these certified programs in preventing overdose, even in the rare instances when coordinated care is employed. Surprisingly, drug misdemeanor charges are correlated to a reduction in overdose deaths, possibly reflecting the success of drug diversion programs that offer treatment over incarceration. Conversely, the legalization of recreational marijuana and the COVID-19 pandemic are strongly associated with higher overdose death rates, potentially due to shifts in drug-use patterns, increased substance availability, and disruptions in addiction treatment services. These findings emphasize the need for sustained access to healthcare and highlight critical gaps in treatment and intervention efforts across New York State.

Keywords: Business Analytics, Opioid Overdose, Mixed-effects model, COVID-19 pandemic

Introduction

It is indicative that drug abuse intervention and drug treatment programs have high costs, but the effectiveness of these systems are questionable. Based on a 2019 annual report for substance use treatment, only 13.9 percent of patients were discharged for completion of the program and 50.2 percent were discharged for dropping out of the program (SAMHSA, 2019). Although New York state treats the most patients for substance abuse disorder out of all 50 states, SAMHSA estimated that 98.9 percent of individuals aged 12 or older with an illicit drug or alcohol use disorder did not receive treatment at a specialty facility in 2021 (NCDAS, 2022; SAMHSA, 2021a). The SAMHSA estimate included individuals who did not perceive a need for treatment and those who acknowledged the necessity of treatment yet failed to pursue it. Despite the availability of substance abuse programs and interventions in New York, there remains a significant gap in understanding why a substantial number of individuals do not seek treatment for substance use disorders. This study aims to address this gap by investigating the factors that influence opioid overdose mortality rates and providing a more comprehensive understanding of the barriers to treatment access.

The initial wave of the opioid epidemic began in the 1990s, driven primarily by overdoses related to prescription opioids. The New York State Office of Addiction Services and Supports (OASAS) was created when the Division of Alcoholism and Alcohol Abuse and the Division of Substance Abuse Services merged in 1992 (State of New York Office of the State Comptroller, 1992). In response to rising overdose deaths, New York State passed a law in April 2006 allowing non-medical individuals to administer Naloxone during an overdose (New York State Department of Health, 2024). Throughout the 2010s, a second surge of opioid overdose deaths emerged from the use of heroin. Numerous campaigns and task forces were launched across New York to address the growing heroin crisis (Intervention Helpline, 2018). Despite the severity of the heroin crisis, a new and even more dangerous threat known as fentanyl began to emerge. By late 2016, the New York City health department released an advisory report confirming that nearly 50 percent of fatal overdoses involved fentanyl (Intervention Helpline, 2018). This trend continued, and by 2021, approximately 80 percent of overdose deaths were linked to fentanyl (NYC Health, 2023).

OASAS manages New York State's substance abuse and alcoholism prevention and treatment programs. Along with this, OASAS oversees the credentialling of all professional substance use counselors and prevention practitioners in New York state. Despite large efforts from New York state to control this crisis by the decade, substance abuse treatment programs face major challenges, including high costs, limited access to care, societal stigma, and systemic barriers (Institute of Medicine (US) Committee on Community-Based Drug Treatment, 1998). These challenges have hindered the effectiveness of many initiatives, hindering widespread access to life-saving treatment for substance abuse. Addressing these obstacles and improving the accessibility of treatment programs could save thousands of lives from opioid overdoses. However, before improving these programs, it is crucial to first analyze the ongoing opioid overdose crisis driving the need for them.

Our study seeks to fill the research gap regarding the opioid overdose crisis in New York State by focusing on underserved populations and county-level variations. Unlike previous research that often centers on New York City, this study examines factors influencing opioid overdose rates across all counties in the state. A key factor in understanding overdose deaths is recognizing the racial disparities in mortality rates. Our study revealed that counties with larger Hispanic or Latino and Asian populations are correlated with higher opioid overdose rates. The disparities among racial groups in overdose rates may stem from a variety of factors, including socioeconomic inequalities, limited access to healthcare services, and structural racism within the healthcare system (Friedman et al., 2024). Research shows that minority populations often experience barriers to accessing addiction treatment, which can result from factors such as the lack of health insurance and fewer treatment facilities (Alegría et al., 2016). Stigma surrounding drug use, particularly in Black and Latino communities, can also discourage individuals from seeking treatment, further amplifying overdose rates (Dayton et al., 2020). Additionally, Black and Hispanic or Latino populations in urban areas are less likely to receive access to life-saving measures for overdose like naloxone (Khan et al., 2023). Addressing these disparities requires targeted interventions, such as increasing the availability of opioid reversal medication, expanding culturally competent care, and improving access to addiction treatment programs (Dayton et al., 2020). Additionally, policies that reduce stigma and increase public awareness about opioid use and treatment options could encourage more individuals from these underserved populations to seek assistance (Dayton et al., 2020).

While there is extensive research on overdose death rates among Black and Hispanic or Latino populations, much less attention has been given to Asian populations. This gap in research may be due to the common perception or stereotype that Asian communities are less affected by the opioid crisis. However, our study found that counties with increasing rates of the Asian population are correlated with higher rates of opioid overdose deaths, highlighting the need for more focused research on substance abuse within these communities. Several factors may contribute to this trend, such as the cultural stigma surrounding drug use (Alegría et al., 2016). The lack of disaggregated data on Asian subgroups further complicates the understanding of overdose risk within these communities (Zhu & Park, 2024). Given these findings, there is an urgent need for more research and targeted interventions aimed at addressing opioid use in Asian communities.

Emergency department visits and hospital discharges play a crucial role in addressing opioid overdoses. Our study examined emergency department visits, including outpatients and admitted patients, involving any opioid overdose, and our results indicate a strong correlation between these visits and rising rates of opioid overdose deaths. Many individuals experiencing opioid use disorder will contact the emergency department during an overdose or withdrawal, yet the mortality after emergency department visit is high (Thomas et al., 2023). Patients often receive a basic referral after a visit, yet they remain at high risk of relapse and subsequent overdose (D'Onofrio et al., 2015). This may be due to the lack of comprehensive follow-up care and support that can significantly contribute to relapse. Additionally, we found that emergency department visits, including outpatients, and hospital discharges involving opioid abuse, dependence, and unspecified use strongly correlates with increasing opioid overdose death rates. Studies report that while emergency department staff are adept at managing the immediate risks of overdose, there is a notable lack of systematic follow-up care for these patients (SAMHSA, 2023). By providing better follow-up care, New York state can reduce the occurrence of someone returning to the emergency department for overdose, thus reducing the overdose mortality rates.

In this study, we investigated the interaction between emergency department visits and hospital discharges involving opioid abuse and admissions to OASAS certified substance use disorder treatment programs for any opioid. This interaction effect examines how the relationship between emergency department visits and hospital discharges for opioid abuse changes depending on the number of admissions to OASAS-certified substance use disorder treatment programs for opioids. Our study found that this interaction effect is significantly correlated to lower rates of opioid overdose deaths across counties in New York. Research has demonstrated that appropriate access to opioid treatment is essential in combating the opioid overdose crisis (Haley et al., 2019). As previously discussed, emergency department visits for overdose and healthcare facility visits for opioid abuse are strongly associated with higher mortality rates of opioid overdose. Despite this, our study shows that if patients are referred to and admitted into OASAS certified substance use disorder treatment programs after emergency department visits and hospital discharges, then this interaction decreases the rate of opioid overdose deaths. One of the key reasons for this reduction may be that treatment programs provide environments where individuals receive comprehensive care including medication-assisted treatment, counseling, and behavioral therapies (Jordan et al., 2024). These interventions address both the physical and psychological aspects of addiction and offer individuals a better chance of sustained recovery, thus reducing the risk of relapse. Outside research on New York State further supports our findings, indicating that the discontinuation or interruption of substance use disorder treatment significantly increases the risk of drug overdose deaths (Kresina et al., 2011). However, ensuring patients follow through with these referrals remains a significant challenge. Therefore, while our findings underscore the importance of integrating healthcare visits and substance use disorder treatment programs, it is equally important to address the barriers of providing sustained support.

Our study incorporated drug-related crime, specifically drug misdemeanor rates, to further analyze the impact this may have on opioid overdose death rates. Research indicates that a significant number of criminals are under the influence of drugs when they commit crime (Rafaiee et al. 2013). Our study observed that drug misdemeanors significantly correlate to lower rates of opioid overdose deaths across counties in New York. This decrease is possibly due to the implementation of drug diversion programs that prioritize treatment over incarceration.

According to the study performed by Chandler et al. (2009), “The criminal justice system provides a unique opportunity to intervene and disrupt the cycle of drug use and crime” (pp. 183–190, Conclusion). Additionally, other research suggests that diversion initiatives, such as drug courts and law enforcement-assisted diversion, help reduce overdose deaths by directing individuals to substance use treatment programs (NIDA, 2014). These diversion programs reduce the likelihood of relapse by providing access to services such as counseling, behavioral therapies, and medication-assisted treatment (Brady, 2018). Our findings highlight the critical role that diversion programs play in lowering opioid overdose deaths. However, it is also essential to focus on removing barriers to treatment and ensuring individuals remain engaged in recovery programs for long-term success.

In our model, we found that events such as the legalization of recreational marijuana and the COVID-19 pandemic were significantly associated with increased rates of opioid overdose deaths. Several studies suggest that these results may be due to complex behavioral and social dynamics. The COVID-19 pandemic severely disrupted access to addiction treatment services and led to increased social isolation and stress, all of which contributed to a rise in substance use and overdose rates (NIDA, 2023). Additionally, the pandemic created barriers to accessing healthcare and support systems, further exemplifying the risks for those with opioid addiction (SAMHSA, 2021b). Regarding marijuana legalization, some research suggests that cannabis can be used as a harm reduction strategy for opioid dependence in certain cases (Mathur & Ruhm, 2023). However, its legalization may also lead to unintended consequences, such as changes in substance use patterns or a reduced perceived risk of drug misuse, which could contribute to higher rates of opioid overdose (Mathur & Ruhm, 2023). These factors, combined with changes in drug availability, economic pressures, and mental health challenges during these periods, likely explain the significant increase in opioid overdose deaths following these events. It is important to recognize that recreational marijuana may offer benefits when used as a substitute for pain medication (Hill et al., 2022). However, our study finds that there is limited evidence supporting the use of recreational marijuana to treat opioid use disorder (Hill et al., 2022). Overall, our findings highlight the need for targeted public health interventions during pivotal societal shifts to mitigate their impact on opioid-related harms.

Literature Review

This study investigates the opioid overdose crisis across New York State counties from 2016 to 2021. We aim to address a gap in the existing literature, as there is a lack of a comprehensive analysis of opioid overdose trends across the entire state during this timeframe. While some studies have focused on specific regions or cities, there is limited research examining state-wide data, particularly across 2016 to 2021. Although varying levels of research have been conducted on the opioid overdose crisis, it is essential to acknowledge the existing studies and highlight the unique contributions of our analysis.

A study from Chen et al. (2018), analyzed opioid poisoning-related hospital visits using New York State SPARCS data and identified various demographic and socioeconomic factors influencing opioid overdoses. They examined the diagnoses of patients who visited hospitals with opioid poisoning as their primary diagnosis for the years 2010 to 2014 and used frequent item mining to find possible causes of opioid poisoning. Chen et al. (2018) revealed correlations between opioid poisoning and demographic and social-economic factors. Our work complements the research done by Chen et al. (2018) by further exploring underserved demographics and understanding the barriers to treatment access causing this disparity. While their study explores opioid poisoning across New York state for the years 2010 to 2014, our approach instead examined opioid mortality across New York state for the years 2016 to 2021. We address a gap in the research, emphasizing not only the demographic patterns but also the impact of COVID-19 and the legalization of recreational marijuana that made a difference in opioid overdose rates across New York State.

In another study that analyzes demographic disparities, Galea et al. (2000) highlights the significant differences in overdose death rates among blacks, Latinos, and whites. Their study notes the prominence of racial/ethnic disparities in overdose mortality trends in New York City between 1990 and 1998. Galea et al. (2000) examined the relationship between drug use patterns and overdose mortality in New York City and found that overdose death in New York City was consistently higher among blacks and Latinos than among whites. They note that further study is warranted to determine the contextual factors that explain the disparities on overdose mortality and our research builds on their findings by exploring how these disparities are influenced by broader statewide factors such as policy, the COVID-19 pandemic, and treatment access.

We believe that there is a research gap from 2016 to 2021 that analyzes opioid overdose mortality on a county-level scale. However, it is important to note a study by Romeiser et al. (2018) that examines the geographic patterns of prescription opioid rates and overdose deaths in New York State from 2013 to 2015. Surprisingly, their study reveals that prescription and mortality clusters do not overlap significantly. Although they found that higher prescription rates do not necessarily correlate with higher mortality rates, their research covers a period during which heroin and synthetic opioids accounted for the majority of overdose deaths. Our research extends this analysis by including all opioids in our model considering the timeframe that synthetic opioids account for most deaths. Despite Romeiser et al. (2018) findings with prescription opioids and mortality, they noted that geographical differences in opioid mortality exist beyond what can be explained by prescription rates. By integrating other factors, such as treatment and policy, that can account for this, our work builds on Romeiser et al. (2018) findings.

Although research is limited on the effectiveness of drug-diversion programs, Prendergast et al. (2002) conducted a meta-analysis on 78 studies of drug treatment conducted between the years 1965 and 1996. A meta-analysis can be defined as combining the results of multiple studies to create a larger sample size (R.H. Riffenburgh, 2012). By including both a control group that did not receive drug treatment and a group that did receive treatment, they found that drug abuse treatment has statistically significant effects in reducing drug use and crime. This finding supports our hypothesis that drug diversion programs may play a role in the negative correlation between drug misdemeanors and opioid overdose mortality rates, as treatment programs can reduce criminal behavior and, potentially, opioid misuse. The evidence found by Prendergast et al. (2002) suggests that such programs may not only address drug-related offenses but also contribute to improved public health outcomes by lowering overdose rates.

While previous studies have contributed valuable insights into the opioid overdose crisis in specific regions or populations, our study aims to address a significant gap in the existing literature by providing a comprehensive, state-wide analysis of opioid overdose trends across New York State from 2016 to 2021. Many studies have focused on isolated areas, such as New York City (Galea et al., 2000) or specific reasons for opioid misuse, such as causes for opioid poisoning (Chen et al., 2018), but few have examined the broader statewide picture, especially over this critical time period. Our research extends existing studies by integrating demographic, healthcare treatment, and policy-level factors. By exploring these factors in the context of opioid overdose deaths across counties, our study aims to identify regional disparities, highlight the utilizations of drug treatment and diversion programs, and provide an understanding of how public health interventions might mitigate overdose mortality in the state across counties.

Methodology

Hypothesis

There are numerous factors that could influence opioid overdose death rates across New York State. We hypothesize that counties with larger Hispanic or Latino populations will exhibit higher rates of opioid overdose deaths, highlighting potential disparities in treatment access and health outcomes. Additionally, we suspect that a greater number of emergency department visits related to opioid overdoses will correlate strongly with increased mortality rates. If proven, this may suggest that emergency care is often not complemented by adequate follow-up treatment, leaving individuals vulnerable to relapse and subsequent overdose. Similarly, we believe that emergency department visits and hospital discharges related to opioid abuse, dependence, and unspecified use will correlate with an increased rate of opioid overdose deaths. This would further suggest that patients that go to these facilities for care will receive inadequate coordinated care after the visit or discharge. We also hypothesize that benzodiazepine prescriptions may increase the rate of opioid overdose deaths because of the potential effect of this medication.

In addition to demographic variables, socioeconomic factors may also play a critical role in determining opioid overdose rates. We hypothesize that the interaction between healthcare facility visits and discharges for opioid abuse and admissions to OASAS-certified drug treatment programs will lower opioid overdose death rates due to the effectiveness of attending substance abuse treatment programs. If adequate follow-up care is provided after an overdose event, we believe that this is effective in reducing opioid overdose mortality rates. We also believe that drug-related misdemeanors will correlate with decreased opioid overdose death rates as drug diversion programs could potentially reduce overdose mortality by emphasizing rehabilitation over incarceration (Chandler et al., 2009). Additionally, we included the legalization of recreational marijuana in New York state to investigate the impact the act will have on opioid overdose. We believe that this act will correlate to higher rates of opioid overdose due to the increased availability of substances and change in drug-use patterns. Moreover, the impact of COVID-19 cannot be overlooked and we anticipate that the pandemic has exemplified existing vulnerabilities and contributed to higher rates of overdose deaths.

Data

All the sources for our data were collected from the years 2016 to 2021. The main source of data we used is the New York State Opioid County Data from the New York State Department of Health. The data matched the CDC National Center for Health Statistics Overdose Death data and included information on emergency department visits, hospital discharges, overdose deaths, and prescriptions. We also included felony and misdemeanor data by county from the New York State Division of Criminal Justice Services. An additional resource we used was demographic data from the United States Census Bureau which included racial population groups, Medicaid enrollment, Medicare enrollment, median earnings, and population data by county in New York State. Additionally, we added information pertaining to the Marijuana Regulation & Taxation Act passed in New York and the COVID-19 pandemic. The variables recreational marijuana and COVID-19 are coded as “0” before the event and “1” after the event. To maintain consistency across our data, we converted all the variables on a crude rate basis per 100,000 population. Many of the variables associated with the NYS Opioid County Data contained cells with a ‘sequela’ as indicated by the value of ‘s’. The sequela is a medical code that indicates an individual has an ongoing condition related to a prior event, such as overdose, and is in need of long-term care. For the purposes of the incident-based objective of this study, we replaced all sequela labels with 0. Joining these datasets together left us with a dataset that has 22,753 observations for the years 2016 to 2021 across 62 counties.

For our mixed-effect model analysis we chose to explore the crude rate for benzodiazepine prescriptions, emergency department visits involving any opioid overdose, and emergency department visits and hospital discharges involving opioid abuse, dependence and unspecified use. Additionally, we included the crude rate for the populations of Hispanic or Latino, White, Black or African American, American Indian and Alaska Native, Asian, Native Hawaiian and other Pacific Islander, some other race, and two or more races. We also included the crude rate for drug felonies, drug misdemeanors, Medicaid enrollment, and Medicare enrollment. To expand our analysis on coordinated care, we included a custom interaction effect between the admissions to OASAS certified substance use disorder treatment programs for any opioid and emergency department visits and hospital discharges involving opioid abuse. An interaction effect helps us understand how these two factors work together to influence the opioid overdose mortality rates. Specifically, we are examining how the relationship between opioid-related emergency department visits and hospital discharges changes depending on the number of admissions to treatment programs for opioid use. This allows us to explore whether increased treatment admissions might modify the effect of emergency care on overdose outcomes, providing a more nuanced understanding of how treatment and emergency interventions interact to affect opioid-related harm. For our analysis, we focused on the crude rate of overdose deaths involving opioids and nonfatal opioid related hospital events. By further analyzing the factors impacting opioid overdose deaths, we can develop an understanding for improving substance use treatment programs. The variable descriptions and variable summary statistics can be found in Figure 1 and Figure 2 below.

Figure 1. Description of variables.

hispanic_or_latino_of_any_race_crude_rate	Crude rate per 100,000 population, of Hispanic or Latino of any race
white_alone_crude_rate	Crude rate per 100,000 population, of White alone
black_or_african_american_alone_crude_rate	Crude rate per 100,000 population, of Black or African American alone
american_indian_and_alaska_native_alone_crude_rate	Crude rate per 100,000 population, of American Indian and Alaska Native alone
asian_alone_crude_rate	Crude rate per 100,000 population, of Asian alone
native_hawaiian_and_other_pacific_islander_alone_crude_rate	Crude rate per 100,000 population, of Native Hawaiian and other Pacific Islander alone
some_other_race_alone_crude_rate	Crude rate per 100,000 population, of some other race alone
two_or_more_races_crude_rate	Crude rate per 100,000 population, of two or more races alone
benzodiazepine_prescription_crude_rate	Crude rate per 100,000 population, of Benzodiazepine prescriptions
ed_opioid_overdose	Crude rate per 100,000 population, of all emergency department visits, including outpatients and admitted patients, involving any opioid overdose
ed_visits_and_hospital_discharges_opioid_abuse	Crude rate per 100,000 population, of all emergency department visits, including outpatients, and hospital discharges involving opioid abuse, dependence, and unspecified use
drug_felony_crude_rate	Crude rate per 100,000 population, of drug felonies
drug_misdemeanor_crude_rate	Crude rate per 100,000 population, of drug misdemeanors
recreational_marijuana	The event of recreational marijuana legalization in New York State
medicaid_enrollment_crude_rate	Crude rate per 100,000 population, of Medicaid Enrollment
medicare_tot_benes_crude_rate	Crude rate per 100,000 population, of Medicare Beneficiaries
covid19	The COVID-19 pandemic
interaction_term2	The interaction between the crude rate per 100,000 population, all emergency department visits, including outpatients, and hospital discharges involving opioid abuse, dependence, and unspecified use and the crude rate per 100,000 population, of admissions to OASAS certified substance use disorder treatment programs for any opioid including heroin
county	Counties in New York State
opioid_overdose_deaths	Crude rate per 100,000 population, of overdose deaths involving opioids and nonfatal opioid related hospital events

Figure 2. Summary statistics on variables.

	Mean	SD	Median	Minimum	Maximum
hispanic_or_latino_of_any_race_crude_rate	7,835.00	9,100.37	4,011.50	1,405.00	56,148.00
white_alone_crude_rate	80,856.47	17,266.23	86,935.50	8,980.00	95,947.00
black_or_african_american_alone_crude_rate	5,764.97	5,948.85	3,948.00	539.00	30,931.00
american_indian_and_alaska_native_alone_crude_rate	374.98	914.93	174.50	12.00	7,150.00
asian_alone_crude_rate	2,850.24	4,017.49	1,275.00	22.00	25,725.00
native_hawaiian_and_other_pacific_islander_alone_crude_rate	29.11	39.04	22.00	0.00	244.00
some_other_race_alone_crude_rate	264.12	353.04	158.00	0.00	2,179.00
two_or_more_races_crude_rate	2,025.09	799.82	1,852.00	749.00	5,269.00
benzodiazepine_prescription_crude_rate	30.92	6.57	31.00	13.00	49.00
ed_opioid_overdose	192.93	316.31	57.00	0.00	1,908.00
ed_visits_and_hospital_discharges_opioid_abuse	583.41	1,190.36	108.00	0.00	6,826.00
drug_felony_crude_rate	95.15	50.59	87.00	0.00	311.00
drug_misdemeanor_crude_rate	191.94	112.36	168.00	22.00	725.00
recreational_marijuana	0.17	0.37	0.00	0.00	1.00
medicaid_enrollment_crude_rate	26,246.06	7,271.39	25,434.00	12,013.00	64,838.00
medicare_tot_benes_crude_rate	21,530.79	3,408.52	21,861.00	13,468.00	38,527.00
covid19	0.33	0.47	0.00	0.00	1.00
interaction_term2	4,047,303.90	13,210,604.58	63,056.00	0.00	78,921,297.00
opioid_overdose_deaths	834.53	1,543.73	185.00	0.00	7,985.00

Model

We used a Mixed Effects Linear Model that includes both fixed effects and random effects to explain opioid overdose death rates. This approach allows us to understand how different factors influence opioid mortality rates while accounting for both general patterns and county-specific differences. The fixed effects account for the predictors, the main factors we are studying, and the random effects account for variability specific to each county. The model can be illustrated with the following formula below:

$$opioid\ overdose\ death\ rate_{ij} = \beta_0 + \sum_{k=1}^{p} \beta_k X_{kij} + u_j + \epsilon_{ij}$$

where β_0 is the overall intercept, $\beta_k X_{kij}$ are the fixed effect terms for each independent variable X_{kij}, u_j is the random effect for each county j, and ϵ_{ij} is the residual error for each observation i in county j. To evaluate whether these effects are statistically significant, we used p-values ($p < 0.05$), where a p-value below this threshold indicates strong evidence that the variable has a meaningful impact on the outcome, rather than the result occurring by chance. Additionally, we examined the coefficients for each significant variable to understand their impact on the opioid overdose death rate. This model allows us to identify key drivers of the crisis that may be specific to certain counties, providing valuable information for targeted interventions and policy recommendations. Furthermore, the ability to quantify the relative contributions of different predictors helps inform public health strategies aimed at reducing opioid-related harm across diverse regions.

Analysis and Results

Figure 3. Findings from the model.

Variable	Coefficient Estimator	95% Confidence Interval
hispanic_or_latino_of_any_race_crude_rate	0.002 ***	0.001–0.003
white_alone_crude_rate	-0.000	-0.001–0.000
black_or_african_american_alone_crude_rate	0.001	-0.001–0.003
american_indian_and_alaska_native_alone_crude_rate	-0.000	-0.005–0.005
asian_alone_crude_rate	0.003 **	0.001–0.004
native_hawaiian_and_other_pacific_islander_alone_crude_rate	-0.010	-0.084–0.064
some_other_race_alone_crude_rate	-0.007	-0.021–0.007
two_or_more_races_crude_rate	-0.005 *	-0.010–-0.000
benzodiazepine_prescription_crude_rate	-0.083	-0.782–0.616
ed_opioid_overdose	1.231 ***	1.209–1.253
ed_visits_and_hospital_discharges_opioid_abuse	1.011 ***	0.993–1.030
drug_felony_crude_rate	0.018	-0.048–0.084
drug_misdemeanor_crude_rate	-0.031 *	-0.062–-0.001
recreational_marijuana	6.290 *	0.007–12.574
medicaid_enrollment_crude_rate	0.001	-0.000–0.002
medicare_tot_benes_crude_rate	-0.000	-0.002–0.001
covid19	10.280 **	3.127–17.433
interaction_term2	-0.000 ***	-0.000–-0.000
Group Var	1.054 *	0.020–2.088

* p-value < 0.001, ** p-value < 0.01, * p-value < 0.05**

The model findings and results can be found in Figure 3 located above. The model results coincide with our hypothesis that disparities in healthcare access and treatment exist among larger populations of Hispanic or Latino groups. Our results show that population groups of Hispanic or Latino significantly correlate with increasing rates of opioid overdose deaths across New York counties. This effect is statistically significant, with a p-value of <0.001, suggesting a strong relationship between the presence of these population groups and higher overdose mortality rates. Socioeconomic inequalities, limited healthcare access, and systemic racism within healthcare could all contribute to these results (Friedman et al., 2024). Unexpectedly, our model also showed that increasing rates of opioid overdose deaths are correlated with larger Asian populations across counties. Similarly to Hispanic or Latino populations, increasing rates of Asian populations are statistically significant with a p-value of <0.001. Cultural stigma surrounding drug use within Asian populations may contribute to these findings, and the absence of disaggregated data on the subgroups of this population adds further challenges (Alegría et al., 2016; Zhu & Park, 2024). Our results also show that increasing rates of Two or more races are negatively correlated with opioid overdose rates, with a p-value of <0.001. Despite the demographic disparities, policies and campaigns that increase awareness and reduce stigma could strengthen more individuals to seek treatment (Dayton et al., 2020).

The findings for healthcare facility visits match our hypothesis. We found that emergency department visits, including outpatients and admitted patients, involving any opioid overdose increases the rate of opioid overdose deaths. This factor is statistically significant with a p-value of <0.001. Additionally, we found that emergency department visits, including outpatients, and hospital discharges involving opioid abuse, dependence, and unspecified use correlates with increasing rates of opioid overdose deaths. Similarly to emergency department visits involving opioid overdose, emergency department visits and hospital discharges involving opioid abuse is statically significant with a p-value of <0.001. These results may be due to the treatment the facility can offer and the lack of follow-up with an individual after visits or discharge. After an overdose, patients are often given a standard referral, which can ultimately result in higher risk of relapse or withdrawal (D'Onofrio et al., 2015). These findings highlight the need for improving post-overdose care and follow-up protocols across counties. Simply providing a referral without support or monitoring may leave individuals vulnerable to falling back into substance use. Contrary to our initial hypothesis, our results show that benzodiazepine prescriptions do not have a significant impact on opioid overdose death rates. Although the co-occurring use of benzodiazepine and opioids can be fatal, benzodiazepine alone have rarely been attributed to the only reason for overdose death (Babalonis & Walsh, 2015). Additionally, benzodiazepine in combination with any opioid only account for 2.8 percent of all overdose deaths involving drugs (National Institutes of Health, 2023). This finding suggests that the primary drivers of opioid-related deaths may lie elsewhere, such as inadequate follow-up care or other co-occurring substance use disorders.

We hypothesized that the interaction between healthcare facility visits and discharges involving opioid abuse, dependence, and unspecified use and admissions to OASAS certified substance use disorder treatment programs for any opioid will correlate with reduced opioid overdose rates. Our results coincide with this hypothesis as this interaction variable is statistically significant with a p-value of <0.001 and decreases opioid overdose death rates across counties. Although substance use disorder treatment programs are underutilized, they have the potential to significantly reduce overdose risks and improve long-term recovery outcomes when accessed consistently. In addition to our findings on drug abuse treatment programs, our model results show that drug misdemeanors correlate with decreasing rates of opioid overdose deaths. As we hypothesized, these findings may be the result of successful drug diversion programs that allow individuals access to substance use disorder programs instead of incarceration. While utilization of these programs remains low, they have been shown to effectively reduce opioid overdose mortality rates. This approach of improving treatment accessibility and supporting diversion programs could create a more robust framework for addressing the opioid crisis. By fostering a healthcare environment that prioritizes treatment over punishment, we can better equip communities to combat addiction. Our findings underscore the urgent need for coordinated care in healthcare, community support, and public policy to mitigate the devastating impact of opioid overdoses.

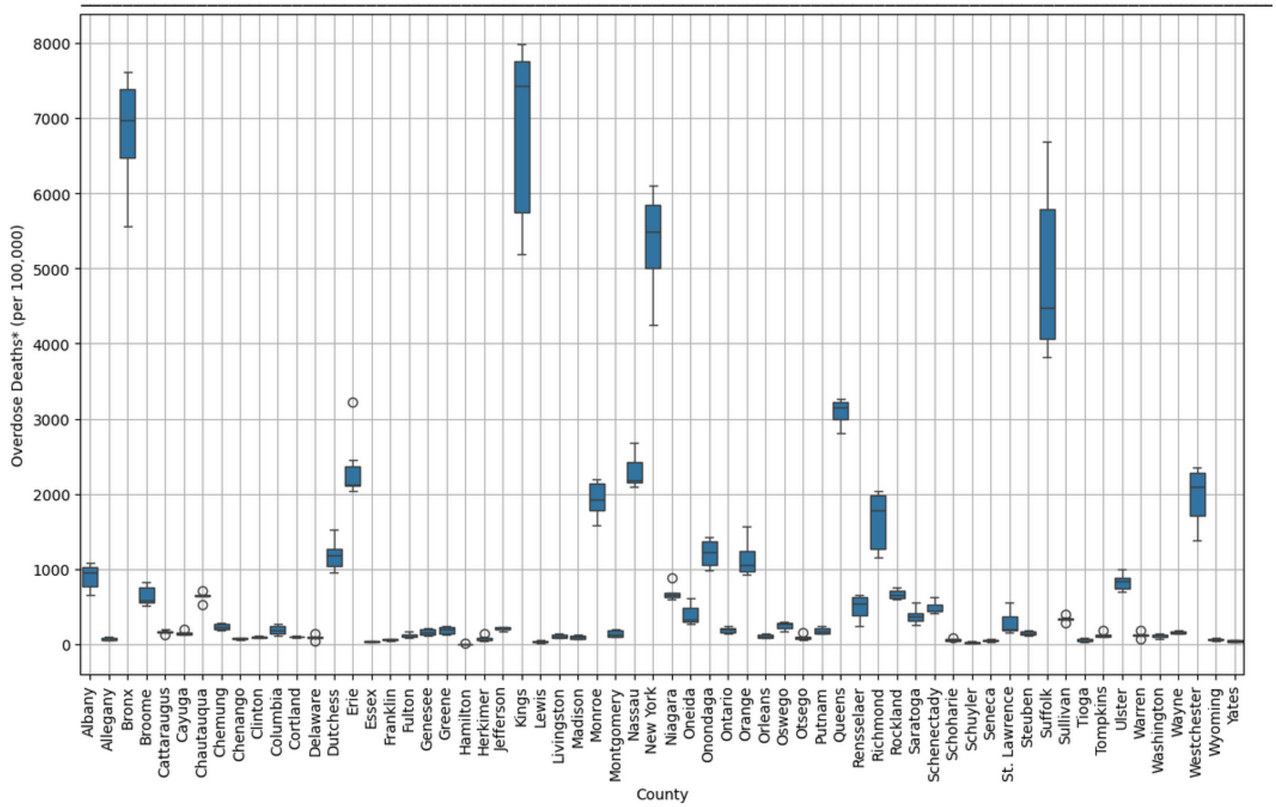
When further investigating the impact of events and policy, our model results for the legalization of recreational marijuana and the COVID-19 pandemic correspond with our initial hypothesis. Our findings show that legislation legalizing recreational marijuana significantly worsened the rate of opioid overdose deaths. These findings suggest that this legalization may contribute to a change in substance use patterns and underscored risk of drug misuse. Our conclusions pertain to individuals that may recreationally use marijuana with opioid use disorder, not in substitution to pain relief medications. Along with this legalization, the COVID-19 pandemic exacerbated the rate of opioid overdose deaths across counties in New York state. This may be possibly due to the disrupted access to substance use disorder treatment programs during the pandemic (NIDA, 2023). In addition, the pandemic amplified overall stress and self-isolation among individuals, which could have possibly increased the rate of substance use (NIDA, 2023).

Discussions and Limitations

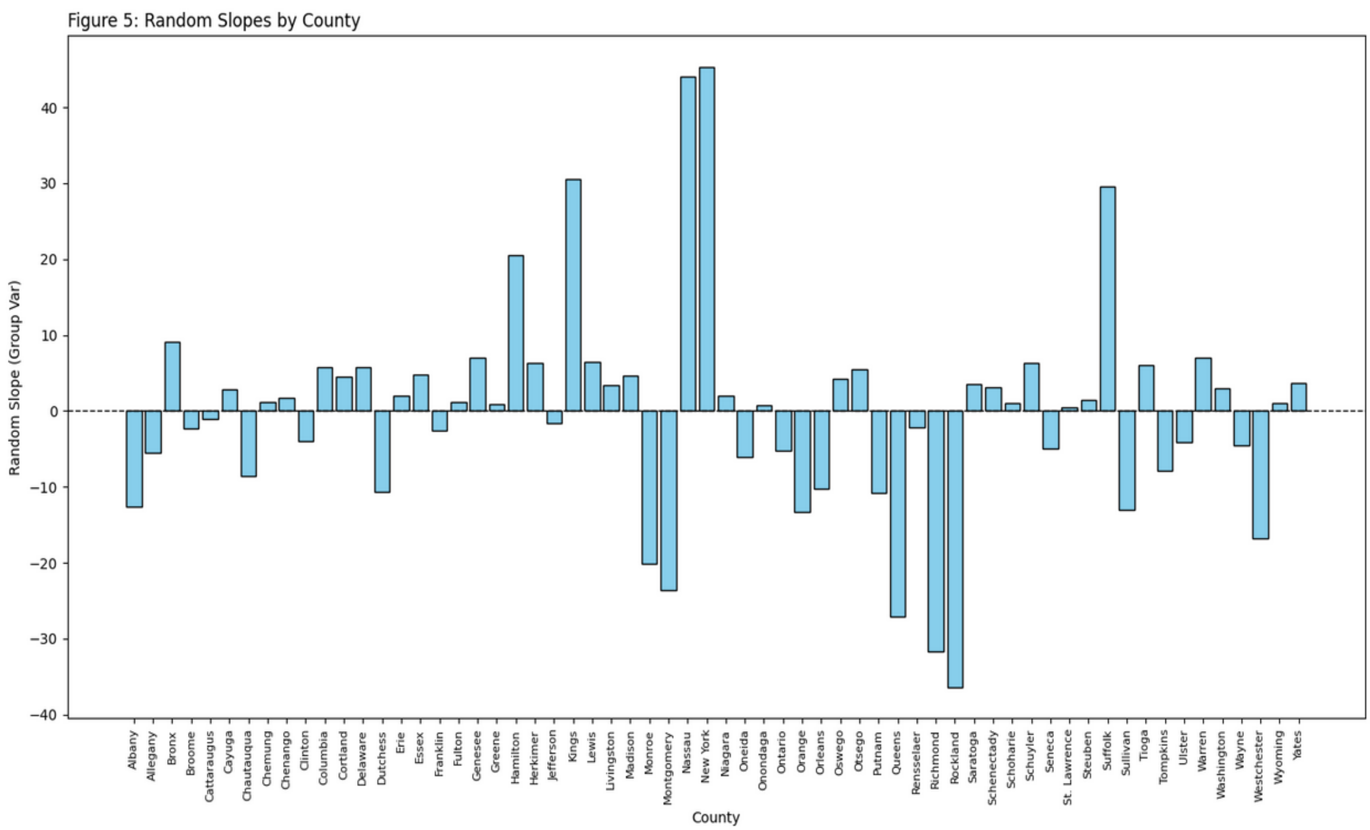
This study explored the various factors influencing opioid overdose deaths across counties in New York State. Our research aimed to further understand the driving need for substance use disorder treatment programs. The underutilization of these programs is significant, but addressing the underlying factors contributing to this issue can help drive new initiatives and raise awareness for the importance of drug treatment programs. The primary focus of our study was on demographic characteristics, healthcare facility visits and discharges, drug-related crime, the legalization of recreational marijuana, and the impact of the COVID-19 pandemic. One of the most unexpected findings was the positive correlation between larger Asian populations and higher opioid overdose death rates. This result is particularly noteworthy, as previous research has often overlooked Asian communities in the context of the opioid epidemic, possibly due to the perception that these groups are less affected by substance abuse (Zhu & Park, 2024). Our findings suggest that cultural stigma surrounding drug use may contribute to the increased vulnerability of Asian populations to opioid overdose (Misra et al. 2021). The interaction effect between healthcare visits for opioid abuse and admissions to OASAS-certified treatment programs also revealed a significant reduction in opioid overdose death rates. These results suggest that improving the integration of emergency department and hospital care with long-term treatment options could significantly enhance outcomes for those struggling with opioid addiction.

Another distinctive finding is the significant association between drug misdemeanor rates and lower opioid overdose death rates. These results suggest that drug diversion programs, which prioritize treatment over incarceration, are playing an important role in reducing overdose fatalities. Previous meta-analysis studies with Prendergast et al. (2002) and (Hayhurst et al., 2017) have found that treatment from drug-diversion programs is effective at reducing drug use. In contrast, our study also identified troubling correlations, such as the strong link between the legalization of recreational marijuana and increased opioid overdose death rates. While marijuana has been suggested as a substitute for opioid use, the shift in drug-use patterns post-legalization may have unintended negative consequences. The increase in overdose deaths could be attributed to polysubstance use or a lowered perception of risk associated with substance use in general. Research coins the term as the “gateway theory” as it refers to the use of tobacco and alcohol followed by drugs such as cocaine or opioids (Zhang et al. 2021). This phenomenon may be contributing to the rise in opioid overdoses following marijuana legalization, as individuals might progress from marijuana to more harmful substances such as opioids.

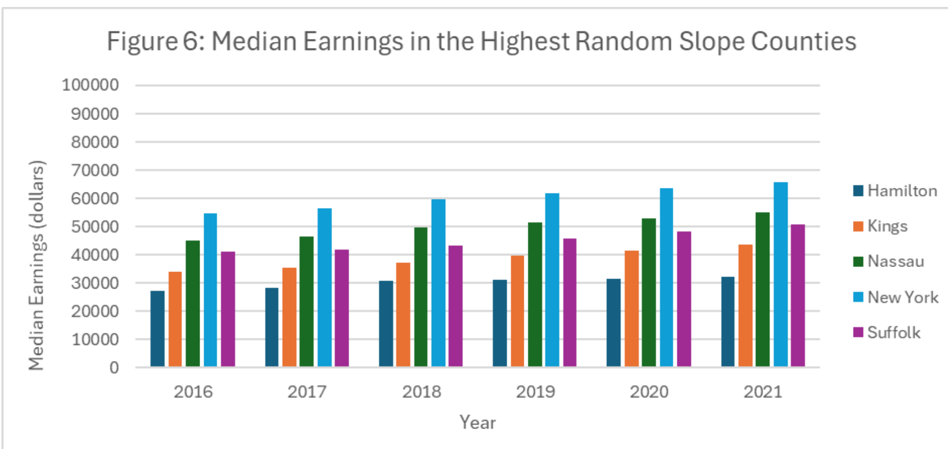
Figure 4. Trends in Overdose Mortality across Counties (95% Confidence Interval)

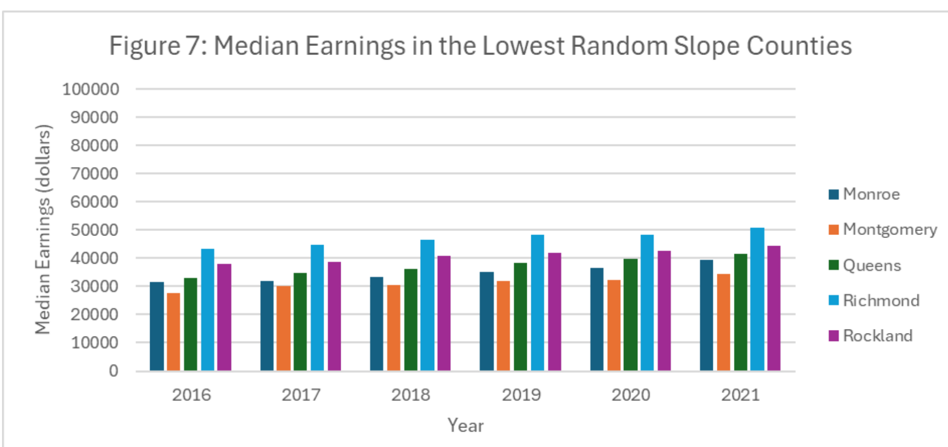


Using Figure 4 above, we further investigated the disparities of opioid overdose mortality across counties in New York State. The figure reveals significant variation across regions, with urban counties (Bronx, Kings, and New York) experiencing much higher overdose death rates in comparison to more rural counties (Allegany, Cattaraugus, and Essex). Bronx and Kings counties show extreme outliers, with overdose rates reaching up to 8,000 per 100,000 individuals. This suggests a disproportionate impact in densely populated areas. In contrast, many rural counties display lower rates with smaller interquartile ranges, indicating fewer overdose fatalities. This analysis implies that geographic or other local factors may be influencing the mortality rates in ways not fully explained by the fixed effects. Although the fixed effects account for opioid overdose mortality rates, they do not explain the variation across counties captured by the random effects. Figure 5, shown below, displays a bar plot of random slopes by county, illustrating how each county deviates from the overall baseline in opioid overdose death rates. The y-axis represents the magnitude of the random effect, indicating the variation in random slope. Positive bars indicate counties with higher than average overdose rates, while negative bars represent counties with lower rates. The horizontal line at 0 marks the overall baseline, with bars above or below reflecting deviations.

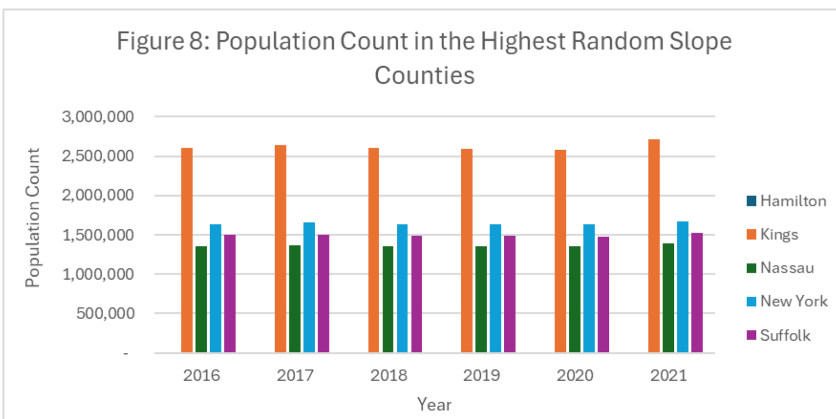


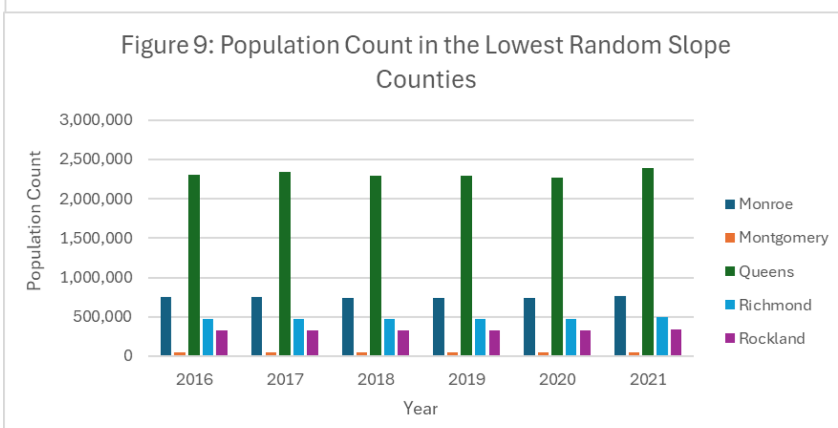
Shown in Figure 5, the counties with the highest random slopes are Hamilton, Kings, Nassau, New York, and Suffolk, indicating that these areas experience the most significant positive deviations in opioid overdose death rates compared to the overall trend. Conversely, the counties with the lowest random slopes are Monroe, Montgomery, Queens, Richmond, and Rockland, reflecting relatively negative deviations from the baseline mortality rates. Although this study cannot fully account for demographic and socioeconomic differences at an individual level, our research can explore potential factors that may contribute to these county-level variations. To understand why certain counties are more severely impacted by the opioid overdose crisis, we examined factors such as median earnings, population size, and the per capita percentage of admissions to OASAS treatment programs. Figure 6 and Figure 7 below illustrate the median earnings over time for counties with the highest and lowest random slopes, respectively. Figure 6 shows that the highest slope counties, despite having higher-than-average opioid overdose rates, also report higher median earnings compared to the lowest slope counties depicted in Figure 7. This finding suggests that higher income levels do not necessarily shield these counties from the severe impacts of the opioid crisis. The results imply that factors beyond economic prosperity, such as access to healthcare, social dynamics, or substance availability, may be driving the elevated overdose rates in these higher-earning counties.





Similarly, an analysis of population graphs, Figures 8 and 9 below, reveals a comparable pattern to the median earnings analysis. It is important to highlight that Hamilton County does not appear in Figure 8 as the population is too small to display. Even though the highest slope counties have larger populations than the lowest slope counties, this demographic factor does not seem to mitigate the heightened rates of opioid overdose. This suggests that neither higher population size nor greater median earnings are sufficient to alleviate the crisis. This is likely because the opioid epidemic is driven by a complex mix of factors beyond economic or demographic characteristics. Research indicates that issues such as access to prescription opioids, social isolation, and strained healthcare resources can contribute significantly to overdose rates, regardless of wealth or population size (Heyman et al., 2019). Therefore, a multifaceted approach that addresses these deeper social and healthcare-related issues is essential for effective intervention.





Understanding the contributing factors to opioid overdose mortality could provide valuable insights and identify where targeted interventions and resources could be most effective. The opioid crisis has led to an increasing need for treatment programs, with counties across the United States experiencing varying levels of admissions to substance use treatment services. In this analysis, we further examine the admissions to the OASAS treatment programs across New York counties to investigate the random effects associated with county variations. Figures 10 and 11 below display the percentage of the population admitted to OASAS treatment programs in the highest and lowest slope counties, respectively, on a yearly basis. Surprisingly, our analysis reveals that the highest slope counties consistently exhibit lower percentages of admissions compared to the lowest slope counties. These findings suggest that despite higher overdose death rates in the highest slope counties, a lower proportion of individuals seek or receive treatment through OASAS programs. These results may be due to larger populations of minority groups in these counties, where systemic barriers and stigma surrounding substance abuse treatment hinder these individuals from seeking treatment. These challenges can prevent access to care, even in areas with higher overdose rates, highlighting the need for targeted interventions to reduce these barriers and increase treatment engagement.

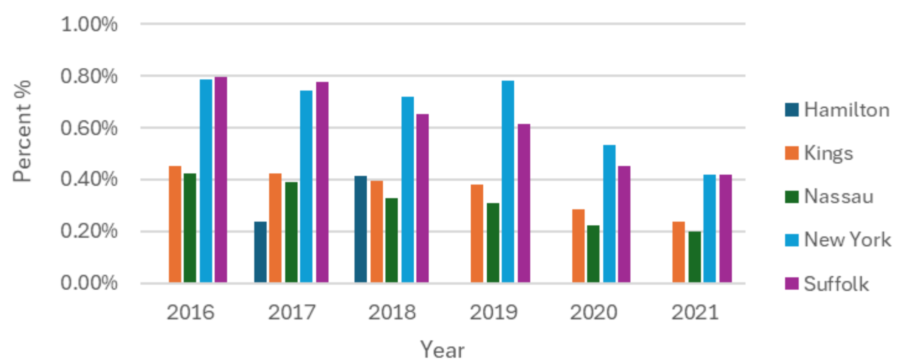
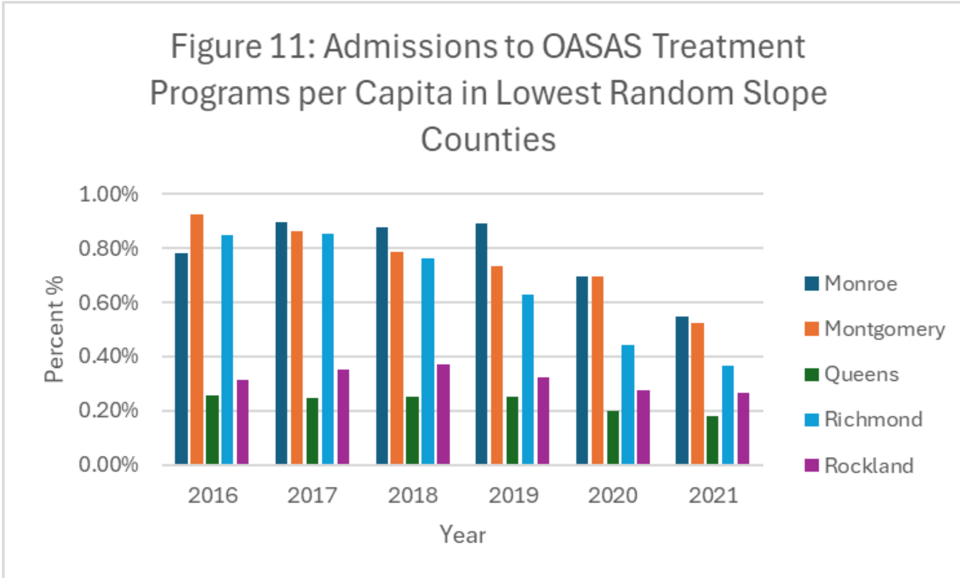


Figure 10: Admissions to OASAS Treatment Programs per Capita in Highest Random Slope Counties



There are several limitations to this study that must be acknowledged. The use of county-level aggregate data limits the ability to capture individual nuances in opioid use and healthcare access. By relying on aggregated data, the analysis overlooks factors such as socioeconomic status, mental health conditions, and individual behaviors that may differently influence opioid overdose rates across diverse populations. Future research could address individual-level factors by incorporating data that captures the unique characteristics and experiences of individuals rather than relying solely on county-level aggregates. This could include collecting data on socioeconomic status, mental health conditions, and personal behaviors, all of which may play a significant role in influencing opioid use and overdose rates. Additionally, we utilize crude rates from the CDC to standardize our variables as our data lacked age-related factors. However, the crude rate does not account for variations in age distribution across different counties, introducing bias. Age-adjusted rates reduce the potential complications from demographic differences. Our data spans from the years 2016 to 2021, which limits the ability to fully access long-term trends or the delayed effects of policy changes. The period following the legalization of marijuana might not reflect the full impact of this policy shift on opioid use patterns. Changes in drug use behaviors and their outcomes can take time to manifest. Similarly, the COVID-19 pandemic's influence on healthcare access and addiction treatment, which saw significant disruptions, may not be fully captured within this timeframe.

Using data from the CDC National Center for Health Statistics, the New York State Division of Criminal Justice Services, and the United States Census Bureau presents several limitations. These data sources include potential issues with data completeness and accuracy, as overdose deaths may be underreported, and criminal justice data might not capture all drug-related offenses. Additionally, there are time lags in data availability and variations in data collection methods that may obscure insights. Furthermore, inherent biases in the datasets may limit contextual information.

Conclusion

Our results highlight the critical factors contributing to the opioid overdose crisis in New York State, revealing important insights between demographics, healthcare, and policy changes. Notably, our findings demonstrate that counties with larger populations of Hispanic or Latino, Asian, and multiracial individuals experience higher rates of opioid overdose deaths. This underscores the urgent need for targeted public health interventions to address the unique challenges faced by these communities.

Moreover, the study emphasizes the significance of coordinated healthcare strategies in reducing overdose mortality. The interaction between healthcare facility visits and discharges for opioid abuse and admissions to OASAS-certified treatment programs illustrates the effectiveness of coordinated care when applied timely and appropriately. Although the utilization of coordinated care is low, when adapted it can lead to improved outcomes for individuals struggling with substance use disorders. These results demonstrate that collaboration between emergency departments, hospitals, and treatment programs can foster a more supportive recovery environment.

To deepen our understanding of the overdose crisis, we analyzed the disparities in overdose mortality rates across New York State counties. The data reveals contrasts between urban and rural areas, with some urban counties exhibiting high rates of overdose deaths. Conversely, some rural counties report significantly lower rates, suggesting fewer incidents of overdose fatalities. Despite those results, our random-slope analysis revealed that addressing the opioid mortality rates lie beyond just fixed effect. We found that this urban-rural divide did not purely address overdose disparities, as some rural counties suffered from higher mortality rates than urban counties (Hamilton and Queens, respectively). Although the median earnings and population count did not explain this difference, the utilization rate of the substance-use disorder treatment programs did explain these disparities. Our analysis highlights the urgent need for targeted public health strategies in counties that may face barriers to accessing treatment. By prioritizing interventions, we can work toward reducing these disparities and fostering a healthier future for all residents of New York State.

As we move forward, the insights gained from this research can inform public health policies and initiatives aimed at combating the opioid crisis. By focusing on the specific needs of vulnerable populations and enhancing the coordination of care, we can work toward a future where fewer individuals are lost to opioid overdoses. This study supports the continued investment in effective treatment that promotes healing and recovery for all affected by the opioid epidemic in New York State.

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